

Validations and descriptions of European syntaxa of vegetation dominated by lichens, bryophytes and algae

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Abstract: Bültmann, H., Roux, C., Egea, J.M., Julve, P., Bricaud, O., Giaccone, G., Täuscher, L., Creveld, M., Di Martino, V., Golubić, S. & Takeuchi, N. *Validations and descriptions of European syntaxa of vegetation dominated by lichens, bryophytes and algae. Lazaroa 36: 107-129 (2015).*

Forty-two high-rank syntaxa and seven associations of the thallophyte system of syntaxa are either described as new or validated in this paper. Among those, there are the following nine classes: *Aspicilieta candidae*, *Caulerpetea racemosae*, *Desmococcetea olivacei*, *Entophysalidetea deustae*, *Gloeocapsetea sanguineae*, *Mesotaenietea berggrenii*, *Naviculetea gregariae*, *Porpidieta zeoroidis*, *Roccelletea phycopsis*. Eleven orders and ten alliances as well as three associations are described or validated: the *Aspicilietalia verruculosae* (incl. *Aspicilion mashiginensis* and *Teloschistion contortuplicati*), the *Caulerpetalia racemosae* (incl. *Caulerpion racemosae*), the *Desmococccetalia olivacei* (incl. *Desmococcion olivacei*), the *Dirinetalia massiliensis*, the *Fucetalia vesiculosi* (incl. *Ascophyllion nodosi*), the *Gloeocapsetalia sanguineae*, the *Lecideetalia confluentis* (incl. *Lecideion confluentis*), the *Mesotaenietalia berggrenii* (incl. *Mesotaenion berggrenii*, *Mesotaenietum berggrenii* and *Chloromonadetum nivalis*), the *Naviculetalia gregariae* (incl. *Oscillatorium limosae* and *Oscillatorietum limosae*), the *Porpidietalia zeoroidis* (incl. *Porpidion zeoroidis*), and the *Roccelletalia fuciformis* (incl. *Paralecanographion grumulosae*). Further, five orders, seven alliances and four associations, classified in known classes, were described as well. These include: the *Bacidinetalia phacodis*, the *Agonimion octosporae* and the *Dendrographetalia decolorantis* (all in the *Arthonio radiatae-Lecidelletea elaeochromae*), the *Staurothelion solventis* (in the *Aspicilieta lacustris*), the *Pediasstro duplicis-Scenedesmium quadricaudae* and the *Pediasstro duplicis-Scenedesmetum quadricaudae* (both in the *Asterionelletea formosae*), the *Peccanion coralloidus* and the *Peltuletalia euplocae* (both in the *Collematetea cristati*), the *Laminarian hyperborea*, the *Saccorhizo polyschidi-Laminarietum* and the *Alario esculenti-Himanthaliatum elongatae* (all in the *Cystoseiretea crinitae*), the *Delesserieta sanguinei*, the *Delesseriion sanguinei* and the *Delesseriium sanguineae* (all in the *Lithophylletea soluti*), as well as the *Rinodino confragosae-Rusavskietalia elegantis* and the *Rhizocarpo geographici-Rusavskion elegantis* (both in the *Rhizocarpetea geographici*).

Keywords: algal vegetation, bryophyte vegetation, cryptogams, International Code of Phytosociological Nomenclature, lichen vegetation, phytosociology, syntaxonomy, vegetation of Europe.

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Resumen: Bültmann, H., Roux, C., Egea, J.M., Julve, P., Bricaud, O., Giaccone, G., Täuscher, L., Creveld, M., Di Martino, V., Golubić, S. & Takeuchi, N. *Descripción y validación de distintos sintáxones europeos de la vegetación dominada por briófitos, líquenes y algas. Lazaroa 36: 107-129 (2015).*

Se describen por primera vez o se validan un total de 42 sintáxones de alto rango y 7 asociaciones correspondientes a distintos tipos de vegetación talofítica y briofítica. Entre ellos se incluyen las 9 clases siguientes: *Aspicilietea candidae*, *Caulerpetea racemosae*, *Desmococetea olivacei*, *Entophysalidetea deustae*, *Gloeocapsetea sanguineae*, *Mesotaenietea berggrenii*, *Naviculetea gregariae*, *Porpidietea zeoroidis*, *Roccelletea phycopsis*. Once órdenes y diez alianzas, además de tres asociaciones pertenecientes a estas clases nuevas, se describen por primera vez o se validan: *Aspicilietalia verruculosae* (incl. *Aspicilion mashiginensis* y *Teloschistion contortuplicati*), *Caulerpetalia racemosae* (incl. *Caulerpion racemosae*), *Desmococetalia olivacei* (incl. *Desmococcion olivacei*), *Dirinetalia massiliensis*, *Fucetalia vesiculosi* (incl. *Ascophyllion nodosi*), *Gloeocapsetalia sanguineae*, *Lecideetalia confluentis* (incl. *Lecideion confluentis*), *Mesotaenietalia berggrenii* (incl. *Mesotaenion berggrenii*, *Mesotaenietum berggrenii* y *Chloromonadetum nivalis*), *Naviculetalia gregariae* (incl. *Oscillatorion limosae* and *Oscillatorietum limosae*), *Porpidietalia zeoroidis* (incl. *Porpidion zeoroidis*), y *Roccelletalia fuciformis* (incl. *Paralecanographion grumulosae*). Además, otros cinco órdenes, siete alianzas y cuatro asociaciones pertenecientes a clases ya descritas se proponen como nuevos: *Bacidinetalia phacodis*, *Agonimion octosporae* y *Dendrographetalia decolorantis* (clase *Arthonio radiatae-Lecidelletea elaeochromae*); *Staurothelion solventis* (clase *Aspicilietea lacustris*); *Pediastro duplisis-Scenedesmion quadricaudae* y *Pediastro duplisis-Scenedesmetum quadricaudae* (clase *Asterionelletea formosae*); *Peccanion coralloidus* y *Peltuletalia euplocae* (clase *Collematetea cristati*); *Laminarion hyperboreae*, *Saccorhizo polyschidi-Laminarietum* y *Alario esculenti-Himanthalietum elongatae* (clase *Cystoseiretea crinitae*); *Delessertetalia sanguinei*, *Delessertion sanguinei* y *Delessertietum sanguineae* (clase *Lithophylletea soluti*); y *Rinodino confragosae-Rusavskietalia elegantis* y *Rhizocarpo geographici-Rusavskion elegantis* (clase *Rhizocarpetea geographici*).

Palabras clave: vegetación algal, vegetación briofítica, vegetación líquénica, criptógamas, Código Internacional de Nomenclatura Fitosociológica, fitosociología, sintaxonomía, vegetación de Europa.

INTRODUCTION

Thallophyte vegetation supposedly had occupied terrestrial habitats long before vascular land plant vegetation evolved (BOMFLEUR & al., 2010). Vegetation of bryophytes, lichens and algae has been subject of description using the BRAUN-BLANQUET (1964) approach since the early days of the method (e.g. FREY, 1923; HILITZER, 1925; MESSIKOMMER, 1927; OCHSNER, 1928; earlier syntaxonomic surveys by KLIKA & HADAČ, 1944; KLIKA, 1948, KLEMENT, 1955). While the vegetation of bryophytes, lichens and macroalgae is reasonably well known, the vegetation of microalgae has been studied rarely: MARGALEF (1944) studied the vegetation of freshwater algae in Spanish mountains, GOLUBIĆ (1967) investigated the vegetation of aerophytic microalgae on calcareous rocks, TÄUSCHER (1998) presented a synopsis for benthic and planktonic freshwater algal vegetation of the lowlands, and KHAYBULLINA & al. (2004, 2005, 2005a) described the vegetation of soil algae. Even vegetation of macrofungi has been described that way, however the system of fungal

communities remains very rudimentary (e.g. PIRK & TÜXEN, 1955, 1957; MICHAEL & al., 1985).

Most monographs deal either with bryophyte, lichen or algae vegetation. Works integrating all thallophyte groups are quite rare (e.g. BARKMAN, 1958). Recent large-scale surveys exist only for bryophyte syntaxa (MARSTALLER, 2006). Still, the thallophyte vegetation is being studied by specialists only, and it has rarely been recognized in vegetation studies. It is often disregarded since it is limited to special habitats and taxonomic expertise is insufficient; usually only a limited number of the larger and more conspicuous terricolous thallophyte species is included in relevé species lists.

The status of the thallophyte communities has been discussed in detail by expert vegetation ecologists familiar with vegetation at different scales (WILMANN, 1966; BARKMAN, 1973). In particular BARKMAN (1973: 460) analysed different approaches used for vegetation description at different scales. In Dutch juniper scrub he distinguished between microcoena delimited by microhabitat and synusia that were floristically defined. He proposed to describe the syntaxa synusia by

applying the Braun-Blanquet-approach and nomenclature the same way as for the classification of phytocoena. The terms *synusia*, *union* and *federation* for community, association and alliance are still occasionally applied (PAUS, 1997), however always with the agreement that such assemblages should be described according to the rules of the ICPN (WEBER & al., 2000).

While the terminology of the units has still not been fixed, researchers mostly followed the procedures of the Braun-Blanquet approach: studied relevés and described floristically delimited units for the thallophyte vegetation using the rank-indicating terminations of the ICPN (-etum, -ion, -alia, -etea). Thallophyte syntaxa based on spatially delimited relevés, classified by floristic criteria and using ranks corresponding to those of the phytocoena are governed by the ICPN (WEBER & al., 2000: Definition I). Independently, authors found it necessary to distinguish between floristically well-delimited thallophyte coenoses and ‘true’ *synusiae* of one-layered stands of few species with identical growth-form occurring within phytocoenoses (e.g. BÜLTMANN, 2005 for reindeer lichen stands in the understorey of pine forests; MARSTALLER, 2006 for the bryophyte vegetation of the *Rhytidiadelphion squarrosi* Waldheim 1944). Therefore the use of terms of the *synusial* system for ‘good’ thallophyte syntaxa seems not advisable anymore. Following BARKMAN (1973), the term *micro-communities*, *micro-associations* etc. might be most suitable. In some cases, *micro-communities* can be very extensive though, e.g. in arctic or mountain regions.

The extensive number of already described thallophyte syntaxa shows that construction of a meaningful *syntaxonomic* system for the thallophytic vegetation is feasible (see also WILMANN, 1998).

The thallophyte communities growing on both natural and artificial rock surfaces are well defined often species-rich. Yet even the most common types have rarely been addresses in *syntaxonomic* studies because of taxonomic problems, especially the rather time-consuming identification of constituent species.

Epiphytic and epixylic communities depend on chemistry and structure of the bark and wood, but are rarely specific to a tree species. These communities are usually excluded from the studies of forest vegetation. SCHUHWERK (1986) showed a possibility to include thallophytic communities in tables of forest relevés by treating them as ‘species’. Unfortunately this useful approach has not been followed by others.

Terricolous thallophytes use the same substrate as vascular plants, but have no roots and are *poikilohydric*. They grow on the surface or occasionally in the pores of the soil (*microalgae*). The thallophytes can grow (1) as single thalli or tiny patches within a *phytocoenose*, (2) as *synusiae* of single growth form, and (3) as stands of bryophytes, lichens and/or algae in spatially delimited spots with scarce or no cover of vascular plants and often in gaps in the vegetation. Only the latter have been described as thallophyte syntaxa.

The thallophyte syntaxa of bryophytes, lichens and algae have been compiled for the first Europe-wide checklist of high ranked syntaxa including the bryophyte, lichen and algal syntaxa (EuroVegChecklist: MUCINA & al., in press). This checklist will include 27 classes, 53 orders and 137 alliances of bryophyte and lichen syntaxa and 13 classes, 24 orders and 53 alliances of algal syntaxa (see Table 1 for an overview). Of those syntaxa nine classes, 16 orders and 17 alliances, almost 14%, were not yet validly described according to the ICPN (WEBER & al., 2000) and therefore are to be described here, alongside with seven new associations.

A NEW ALLIANCE IN THE *ASPICILIETEA LACUSTRIS*

The *Aspiclietea lacustris* Wirth 1972 includes only one order – the *Hydroverrucarietalia* Èrenohorský et Hadaè ex Klement 1955. The vegetation on acidic rocks is rather well studied, but the syntaxa from calcareous substrates are less known. ASTA & al. (1973a) described the *Staurotheletum solventis* from submerged cal-

careous rocks of the high-mountain regions of France that cannot be placed within any currently recognised alliance. The *Staurothelion solventis* is described (see below) to accommodate the aquatic lichen communities on calcareous rocks from high mountains, in addition to the *Verrucarium siliceae* Wirth 1972, the *Aspicilion lacustris* Klement 1950, and the *Porinion lectissimae* Wirth 1980 from acidic substrates. The *Staurothelion solventis* includes the type association and one provisionally described community (ASTA & al., 1973a).

***Staurothelion solventis* Roux all. nov. hoc loco**
(*Hydroverrucarietalia*, *Aspicilieta lacustris*)

TYPE: *Holotypus hoc loco*: *Staurotheletum solventis* Asta, Clauzade et Roux 1973 (ASTA & al., 1973a: 75-81).

CHARACTER TAXA OF THE ALLIANCE: *Placynthium tantaleum*, *Polyblastia ardesiaca*, *Staurothele sapaudica*, *S. solvens*.

A NEW ORDER AND AN ALLIANCE IN
THE RHIZOCARPETEA GEOGRAPHICI

The species diversity of lichens on siliceous rocks is higher than on any other substrate (BÜLTMANN, 2010). The *Rhizocarpetea geographicici* Wirth 1972 is a very large class, comprising six orders (*Rhizocarpetalia obscurati* Wirth 1980, *Rhizocarpetalia* Klement 1949 *nom. conserv. propos.*, *Acarosporetalia sinopicae* Creveld 1981, *Umbilicarietalia* Oberdorfer ex Klika et Hadač 1944, *Parmelietaalia saxatilis* Wirth 1972 and *Rinodino confragosae-Rusavskietalia elegantis*). The latter is a new order comprising sub-nitrophilous lichen communities on subacidic siliceous rocks and on acidic rocks irrigated by calcium-rich water. Characteristic is the combination of acidophytes and nitrophilous neutrophytes, indifferent species and weak basiphytes. Besides the type alliance, the *Rhizocarpo-Rusavskion* (see below), the order includes also the *Lecanorion rubinae* Frey 1933 on nutrient enriched tops of

bird rocks in the subalpine to nival belts and in the Arctic, and the thermophilous *Physcion dimidiatae* Wirth 1972.

The validation of the order became necessary because CREVELD (1981) chose the invalidly published *Rhizocarpo-Xanthorion* Creveld 1981 as the type alliance, hence rendering the order invalidly described as well.

The conspicuous orange stands of *Rusavskia elegans* (formerly better known as *Xanthoria elegans*) are typical for sites with a strong influence of bird manure on subacidic and calcareous rocks. Similar communities on calcareous rocks, however, belong in the *Verrucarietalia nigrescentis*.

***Rinodino confragosae-Rusavskietalia elegantis* Creveld ordo nov. hoc loco**
(*Rhizocarpetea geographicici*)

VALIDATED NAME: *Rinodino confragosae-Xanthorietalia elegantis* Creveld 1981 (CREVELD, 1981: 87) [ICPN Art. 17] *Xanthoria elegans* (Link) Th. Fr. is a synonym of *Rusavskia elegans*.
SYNONYMS: *Neuropogonetalia* Mattick 1951 [Art. 2b], *Physcietalia caesia* Mattick 1951 p.p. [Art. 2b], *Physcietalia* Hadač 1962 [Art. 2b], *Physcietalia caesia* Mattick ex Creveld 1981 [Art. 17].

TYPE: *Holotypus hoc loco*: *Rhizocarpo geographicici-Rusavskion elegantis* Creveld in Bültmann & al., 2015 (see below).

CHARACTER TAXA OF THE ORDER: *Caloplaca vitellinula*, *Candelariella vitellina*, *Myriospora scabrida*, *Rhizoplaca melanophthalma*, *Rinodina confragosa*.

DIFFERENTIAL SPECIES AGAINST THE OTHER ORDERS ON STRONGLY ACIDIC ROCKS ARE NEUTROPHYTES OR CALCIPHYTE: *Candelariella aurella*, *Lecania erysibe*, *Lecanora dispersa*, *Phaeophyscia orbicularis*, *Placynthium nigrum*.

***Rhizocarpo geographicici-Rusavskion elegantis* Creveld all. nov. hoc loco**
(*Rinodino confragosae-Rusavskietalia elegantis*, *Rhizocarpetea geographicici*)

VALIDATED NAME: *Rhizocarpo-Xanthorion* Crevelde 1981 (CREVELDE, 1981: 88) [Art. 3g].

SYNONYMS: *Neuropogion melaxathi* Mattick 1951 [Art. 2b], *Physcion caesia* Mattick 1951 [Art. 2b], *Caloplacion elegantis* Hadač 1962 [Arts. 2b, 3b], *Xanthorion elegantis* Dubiel et Olech 1990 [Art. 3b].

TYPE: *Holotypus hoc loco*: *Buellio nivalis-Xanthorietum elegantis* Crevelde 1981 (CREVELDE, 1981: 89-92, Table II, relevés 1-16).

CHARACTER TAXON OF THE ALLIANCE: *Physcia caesia*.

NEW LICHEN SYNTAXA ON CALCIFEROUS SCHISTS AND DECALCIFIED ROCKS IN THE ALPS

ASTA & ROUX (1977) and ROUX (1981) described (for the high-rank syntaxa preliminary, hence invalidly) lichen vegetation of calcareous schists and decalcified rocks at high altitudes of the Alps. The *Aspicilieta candidae* comprises the achionophytic vegetation types with the sub-thermophilous and the sub-xerophilous order *Aspicilietalia verruculosae* and the less thermophilous *Lecideetalia confuorescentis*. The *Aspicilietalia verruculosae* comprises two alliances that differ in the carbonate content of the rock – the *Aspicilion mashiginensis* (showing low carbonate content) and the *Teloschistion contortuplicati* (slightly higher or higher carbonate content).

The new class *Porpidieta zeoroidis*, comprising a new order and alliance, was coined to accommodate chionophytic lichen vegetation.

In the sequel we validate these syntaxa:

Aspicilieta candidae Asta et Roux ex Roux **class. nov. hoc loco**

VALIDATED NAME: *Aspicilieta candidae* Asta et Roux 1977 (ASTA & ROUX, 1977: 69–70) [Art. 3b].

SYNONYM: *Aspicilieta candidae* Asta et Roux in Roux 1981 (ROUX, 1981: 133) [Art. 3b].

TYPE: *Holotypus hoc loco*: *Aspicilietalia verru-*

culosae Asta et Roux ex Roux in Bültmann et al. 2015 (see below).

CHARACTER TAXA OF THE CLASS: *Acarospora freyi*, *Aspicilia candida*, *Lecidea tessellata* var. *caesia*, *L. umbonata*.

Aspicilietalia verruculosae Asta et Roux ex Roux **ordo nov. hoc loco** (*Aspicilieta candidae*)

VALIDATED NAME: *Aspicilietalia verruculosae* Asta et Roux 1977 (ASTA & ROUX, 1977: 69-70) [Art. 3b].

SYNONYM: *Aspicilietalia verruculosae* Asta et Roux in Roux 1981 (ROUX, 1981: 134) [Art. 3b].

TYPE: *Holotypus hoc loco*: *Aspicilion mashiginensis* Asta et Roux ex Roux in Bültmann et al. 2015 (see below).

CHARACTER TAXA OF THE ORDER: *Aspicilia polychroma* subsp. *polychroma* chemotype *verruculosa*, *Caloplaca anchon-phoeniceon*, *C. insularis*.

Aspicilion mashiginensis Asta et Roux ex Roux **all. nov. hoc loco** (*Aspicilietalia verruculosae*, *Aspicilieta candidae*)

VALIDATED NAME: *Aspicilion mastrucatae* Asta et Roux 1977 (ASTA & ROUX, 1977: 69-70) [Art. 3b].

SYNONYM: *Aspicilion mastrucatae* Asta et Roux in Roux 1981 (ROUX, 1981: 134) [Art. 3b] *A. mastrucata* auct. non (Wahlenb.) Th. Fr. is a synonym of *Aspicilia mashiginensis*.

TYPE: *Holotypus hoc loco*: *Lecanoretum albulae* Asta et Roux 1977 (ASTA & ROUX, 1977: 55, Table 20 on pp. 58-59).

CHARACTER TAXA OF THE ALLIANCE: *Acarospora hospitans*, *A. impressula*, *Aspicilia mashiginensis*, *A. permutata*.

Teloschistion contortuplicati Roux **all. nov. hoc loco** (*Aspicilietalia verruculosae*, *Aspicilieta candidae*)

TYPE: *Holotypus hoc loco*: *Teloschistetum contortuplicati* Asta et Roux 1977 (ASTA & ROUX, 1977:

39; Table 11 on pp. 42-43). *Teloschistes contortuplicatus* (Ach.) Clauzade & Rondon, is often listed as *Seiophora contortuplicata* (Ach.) Frödén, in Frödén & Lassen, however the separation from *Teloschistes* has not been confirmed yet.

CHARACTER TAXA OF THE ALLIANCE: *Acarospora freyi*, *A. scabra*, *Carbonea atronivea*, *Diplotomma dispersum*, *Lecanora diaboli*, *Polysporina pusilla*, *Teloschistes contortuplicatus*.

***Lecideetalia confluentis* Roux ordo nov. hoc loco**

(*Aspicilietea candidae*)

TYPE: *Holotypus hoc loco*: *Lecideion confluentis* Roux in Bültmann et al. 2015 (see below).

CHARACTER TAXA OF THE ORDER: *Bellemerea subcandida*, *Farnoldia micropsis*, *Thelidium ungeri*, *Verrucaria fischeri* (syn. *V. tristis* (Massal.) Krempel.)

***Lecideion confluentis* Roux all. nov. hoc loco**

(*Lecideetalia confluentis*, *Aspicilietea candidae*)

TYPE: *Holotypus hoc loco*: *Lecideetum confluentis* Asta et Roux 1977 (ASTA & ROUX, 1977: 33; Table 7 on pp. 34-35).

CHARACTER TAXA OF THE ALLIANCE: *Lecanora dispersoareolata*, *Lecidea confluentis*, *L. leprosolimbata*, *L. speirodes*.

***Porpidietea zeoroidis* Roux class. nov. hoc loco**

TYPE: *Holotypus hoc loco*: *Porpidietalia zeoroidis* Asta et Roux ex Roux in Bültmann et al. 2015 (see below).

CHARACTER TAXA OF THE CLASS: *Adelolecia kolaensis*, *Polyblastia cupularis* var. *cupularis*, *Porpidia zeoroides*, *Rhizocarpon petraeum*.

***Porpidietalia zeoroidis* Asta et Roux ex Roux ordo nov. hoc loco**

(*Porpidietea zeoroidis*)

TYPE: *Holotypus hoc loco*: *Porpidion zeoroidis* Asta et Roux ex Roux all. nov. (see below).

CHARACTER TAXA OF THE ORDER: *Adelolecia kolaensis*, *Polyblastia cupularis* var. *cupularis*, *Porpidia zeoroides*, *Rhizocarpon petraeum*.

***Porpidion zeoroidis* Asta et Roux ex Roux all. nov. hoc loco**

(*Porpidietalia zeoroidis*, *Porpidietea zeoroidis*)

VALIDATED NAME: *Huilion macrocarpae-trullisatae* Asta et Roux 1977 (ASTA & ROUX, 1977: 69-70) [Art. 3b].

SYNONYM: *Huilion macrocarpae-trullisatae* Asta et Roux in Roux 1981 (ROUX, 1981: 135, 137-138) [Art. 3b] *Huilia macrocarpa* (DC.) Hertel var. *trullisata* (Arnold) Hertel is a synonym of *Porpidia zeoroides*.

TYPE: *Holotypus hoc loco*: *Stenhammarelletum turgidae* Hertel ex Asta, Clauzade et Roux 1973 (ASTA & al., 1973b: 547-563, Table 1, rel. 1-8; subassociation of *Stenhamarella turgida* = *Stenhammarelletum turgidae* sensu Asta et Roux 1977) The group of relevés named ‘subassociation of *Lecidea confluentis*’ in 1973 was reclassified as the *Lecideetum confluentis* and classified in the *Aspicilietea candidae* by ASTA & ROUX (1977).

CHARACTER TAXA OF THE ALLIANCE: *Adelolecia kolaensis*, *Polyblastia cupularis* var. *c.*, *Porpidia zeoroides*, *Rhizocarpon petraeum*

VALIDATION OF SYNTAXA OF JELLY LICHENS ON LIMESTONE AND BASE-RICH ROCKS

The *Collematetea cristati* Wirth 1980 is a class of cyanobacterial lichen communities on calcareous or base-rich rocks, dominated by jelly lichens. This growth form can accumulate the occasional supply of seepage water and become swollen and jelly-like when wet. The *Collematetalia cristati* Wirth 1980 comprises vegetation on limestone with the thermophilous *Peccanion coralloidis* in well illuminated and the *Collemation tuniformis* Klement 1955 corr. Wirth 1980 in shaded habitats. The other order, the *Peltuletalia euplocae* (com-

prising the *Peltulion euplocae* Llimona et Egea 1984) accommodates the jelly lichen syntaxa on base-rich siliceous rocks.

***Peccanion coralloidis* Moreno et Egea ex Egea
all. nov. hoc loco**

(*Collematetalia cristati*, *Collematetea cristati*)

VALIDATED NAME: *Peccanion coralloides* Moreno et Egea 1991 (MORENO & EGEA, 1991: 74) [Art. 3b].

SYNONYMS: *Dermatocarpion miniati* Mattick 1951 p.p. [Art. 2b], *Psorotichion schaeereri* Wirth 1995 [Art. 3b].

TYPE: *Holotypus hoc loco*: *Peccanion coralloidis-Thyreetum pulvinatae* Nowak 1960 (NOWAK, 1960: 367-370, Table 16).

CHARACTER TAXA OF THE ALLIANCE: *Anema decipiens*, *A. nummularium*, *Lichinella iodopulchra*, *Metamelanena caesiella*, *Peccania coralloides*, *Placynthium subradiatum*, *Psorotichia diffracta*, *P. frustulosa*, *P. schaeereri*, *Pterygiopsis affinis*, *Thyrea girardii*.

***Peltuletalia euplocae* Morena et Egea ex Egea
ordo nov. hoc loco**

(*Collematetea cristati*)

VALIDATED NAME: *Peltuletalia euplocae* Llimona et Egea 1985 (LLIMONA & EGEA, 1985: 443) [Art. 3b].

SYNONYM: *Peltuletalia euplocae* Morena et Egea 1991 (MORENO & EGEA, 1991: 74) [Art. 3b].

TYPE: *Holotypus hoc loco*: *Peltulion euplocae* Llimona et Egea 1985 (LLIMONA & EGEA, 1985: 433-443).

CHARACTER TAXA OF THE ORDER: *Collema rysesoleum*, *Lichinella cribellifera*, *Peltula euploca*, *P. omphaliza*, *P. placodizans*.

The holotype *Peltulion euplocae* Llimona et Egea 1985 is a later homonym of the *Peltulion euplocae* Llimona et Egea 1984 (LLIMONA & EGEA, 1984: 92). We have decided to follow MORENO & EGEA (1991) and chose the younger homonym as the type for the *Peltuletalia*.

**VALIDATION OF THE *ROCCELLETEA*
PHYCOPSIS, WITH NEW ORDERS AND
AN ALLIANCE**

The ombrophobic and aerohygrophilous rock lichen communities of this class are supported by calcareous to subacidic substrates, found in rather well-illuminated rock overhangs. The class is optimally developed in Southern Europe, Macaronesia and North Africa. It includes conspicuous stands of large fruticose *Roccella* species, several of them formerly harvested for the production of dye. Syntaxa from carbonate rocks are classified in the *Dirinetalia massiliensis*, with one alliance - the *Roccellion phycopsis* Egea et Llimona 1984, those from subacidic to subneutral rocks in the order *Roccelletalia fuciformis* (with the moderately aero-hygrophilous *Paralecanographion grumulosae* and the highly aero-hygrophilous *Roccellion* Klement 1965).

***Roccelletea phycopsis* Egea class. nov. hoc loco**

VALIDATED NAME: *Roccelletea phycopsis* Egea 1989 (EGEA, 1989: 112) [Art. 3b].

SYNONYMS: *Physcietea* Mattick 1951 p.p. [Art. 2b], *Physcietea* Tomaselli 1956 [Art. 2b], *Roccelletea phycopsis* Follmann 1993 [Art. 3b].

TYPE: *Holotypus hoc loco*: *Dirinetalia massiliensis* Egea in Bültmann et al. 2015 (see below).

CHARACTER TAXA OF THE CLASS: *Alyxoria sublevata*, *Dirina massiliensis* morphotype *sorediata*, *Roccella phycopsis*, *Thelopsis isiacae*.

***Dirinetalia massiliensis* Egea ordo nov. hoc loco**

(*Roccelletea phycopsis*)

VALIDATED NAME: *Dirinetalia massiliensis* Egea 1989 (EGEA, 1989: 112) [Art. 3b].

SYNONYMS: *Roccelletalia vicentinae* Follmann 1993 p.p. [Art. 3b].

TYPE: *Holotypus hoc loco*: *Roccellion phycopsis* Egea et Llimona 1984 (EGEA & LLIMONA, 1984: 210).

CHARACTER TAXA OF THE ORDER: *Aloxyria mougeotii*, *A. variiformis*, *Dirina massiliensis* morphotype *massiliensis*.

***Roccelletalia fuciformis* Egea ordo nov. hoc loco**

(*Roccelletea phycopsis*)

VALIDATED NAME: *Roccelletalia fuciformis* Egea 1989 (EGEA, 1989: 113) [Art. 3b].

SYNONYMS: *Physcietalia caesia* Mattick 1951 p.p. [Art. 2b], *Roccelletalia vicentinae* Follmann 1993 p.p. [Art. 3b].

TYPE: *Holotypus hoc loco*: *Roccellion* Klement 1965 (KLEMENT, 1965: 516).

CHARACTER SPECIES OF THE ORDER: *Roccella fuciformis*, *R. tinctoria*, *R. tuberculata*.

***Paralecanographion grumulosae* Egea all. nov. hoc loco**

(*Roccelletalia fuciformis*, *Roccelletea phycopsis*)

VALIDATED NAME: *Lecanactidion monstrosae* Egea 1989 (EGEA, 1989: 113) [Art. 3b] *Lecanactis monstrosa* Bagl. = *Lecanactis grumulosa* (Dufour) Fr. var. *monstrosa* (Bagl.) Grummann on acidic substrate had been separated from the more basiphytic var. *grumulosa*, but is now included in *Paralecanographa grumulosa*.

TYPE: *Holotypus hoc loco*: *Lecanactino monstrosae-Dirinetum insulanae* Egea 1989 (EGEA, 1989: 114, 138-140).

CHARACTER SPECIES OF THE ALLIANCE: *Lecanographa dialeuca*, *Opegrapha cesareensis*, *O. lutulenta*, *Paralecanographa grumulosa*, *Roccellographa circumscripta*.

TWO NEW ORDERS AND AN ALLIANCE IN THE ARTHONIO RADIATAE-LECIDELLETEA ELAEOCHROMAE

The *Arthonio-Lecidelletea* comprises epiphytic communities dominated mostly by crustose lichens growing on smooth tree bark with a

neutral to moderately acidic bark pH. The *Graphidetalia scriptae* Hadač in Klika et Hadač 1944 (with two alliances) occur on very smooth bark, beech in particular, in moderately humid sites; the *Bacidinetalia phacodis* (with one alliance - the *Agonimion octosporae*) on more porose bark of older trees in shaded and humid situations, and the *Dendrographetalia decolorantis* (with the *Lecanactidion patellarioides* Crespo ex Giralt 1996) occur in rather dry habitats and has southern distribution.

***Bacidinetalia phacodis* Bricaud et Roux ordo nov. hoc loco**

(*Arthonio radiatae-Lecidelletea elaeochromae*)

VALIDATED NAME: *Bacidietalia phacodis* Bricaud et Roux 2004 (BRICAUD, 2004: 25, 211) [Art. 3b].

TYPE: *Holotypus hoc loco*: *Agonimion octosporae* Bricaud et Roux in Bültmann et al. 2015 (see below).

CHARACTER TAXA OF THE ORDER: *Bacidia fraxinea*, *Bacidina phacodes*, non-lichenised fungi: *Aleurodiscus disciformis*, *Dendrominia dryina*, *Didymosphaeria rubicola*, *Septobasidium quercinum*.

***Agonimion octosporae* Bricaud et Roux all. nov. hoc loco**

(*Bacidietalia phacodis*, *Arthonio radiatae-Lecidelletea elaeochromae*)

VALIDATED NAME: *Agonimion octosporae* Bricaud et Roux 2004 (BRICAUD, 2004: 43-44, 311) [Art. 3b].

SYNONYM: *Bacidion rubellae* Wirth 1995 [Art. 3b]. TYPE: *Holotypus hoc loco*: *Hypocenomycetum stoechadianae* Abbassi Maaf et Roux 1987 (ABBASSI MAAF & ROUX, 1987: 219-227, Table on pp. 224-227).

CHARACTER TAXA OF THE ALLIANCE: *Bacidia rubella*, *Biatoridium monasteriense*, *Coenogonium luteum*, *Gyalecta derivata*, *G. flotowii*, *G. liguriensis*, *Navicella pileata* (non-lichenised fungus), *Thelopsis rubella*.

Dendrographetalia decolorantis* Bricaud et Roux ordo nov. hoc loco(Arthonio radiatae-Lecidelletea elaeochromae)*

VALIDATED NAME: *Schismatommetalia decolorantis* Bricaud et Roux 2004 (BRICAUD, 2004: 43, 91, 311) [Art. 3b] *Schismatomma decolorans* (Turner et Borrer ex Sm.) Clauzade et Vizda is a synonym of *Dendrographa decolorans*.

SYNONYMS: *Lecanoretalia sienae* Crespo 1981 p.p. [Art. 1], *Lecanoretalia sienae* Crespo ex Crespo et Bueno 1984 p.p. [Art. 2b], *Lecanoretalia sienae* Crespo ex Giral 1996 p.p. [Art. 5], *Lecanoretalia sienae* Crespo ex Boqueras 2000 p.p. [Art. 2b].

TYPE: *Holotypus hoc loco*: *Lecanactidion patellarioidis* Crespo ex Giral 1996 (GIRALT, 1996: 423, 426-427).

CHARACTER TAXA OF THE ORDER: *Bactrospora patellarioides*, *Dendrographa decolorans*.

(*Lecanactis patellarioides* (Nyl.) Vain. is a synonym of *Bactrospora patellarioides*).

GIRALT (1996) adopted the concept of the name by using *Lecanactidion patellarioidis* Crespo 1981 ined. (not effectively published). By adopting the name with only one valid association - the *Dirinetum ceratonie* Klement 1965 (=type), and by listing characteristic species, the name *Lecanactidion patellarioidis* had been validated by GIRALT (1996).

VALIDATION OF THE *NAVICULETEA* WITH AN ORDER AND ALLIANCE FOR BENTHIC MICROALGAL COMMUNITIES IN FRESH AND BRACKISH WATERS

The *Naviculetea* was proposed by PANKOW (1980) as a provisional class and the order *Naviculetalia* Pankow 1980 was invalidly published because it was not possible to establish which of several *Navicula* species in the original diagnosis of the syntaxon name served as the eponymous taxon name.

The order includes the *Oscillatorion limosae* (cyanobacterial and diatom communities in eutrophic and brackish lowland waters), the

Melosirion variantis Margalef 1951 (syn. *Meridio circularis-Naviculion gregariae* M. Schlüter 1961) comprising benthic diatom communities in eutrophic or brackish lowland waters, and the *Cymbello-Synedrion capitatae* M. Schlüter 1961 comprising benthic diatom communities of small eutrophic lowland ponds. In addition, at least nine alliances were described by MARGALEF (1949, 1950, 1951) for the benthic algae communities in Spanish mountains for a variety of water chemistries. It may well be that new orders or classes for those communities should be defined in future. Those alliances of MARGALEF (l.c.) were tentatively included in the *Naviculetalia* (*Naviculetea*).

***Naviculetea gregariae* Pankow ex Täuscher class. nov. hoc loco**

VALIDATED NAME: *Naviculetea* Pankow 1980 (PANKOW, 1980: 136) [Art. 3b, 3g].

SYNONYM: *Naviculetea* Pankow ex Täuscher 1998 (TÄUSCHER, 1998: 631) [Art. 2b, 3g].

TYPE: *Holotypus hoc loco*: *Naviculetalia gregariae* Pankow ex Täuscher in Bültmann et al. 2015 (see below).

CHARACTER TAXA OF THE CLASS: *Achnanthes brevipes*, *Amphora coffaeiformis*, *A. ovalis*, *Anomoeoneis sphaerophora*, *Aphanothece stagnina*, *Brebissonia boeckii*, *Caloneis amphisbaena*, *Calothrix scopulorum*, *Cocconeis placentula*, *Coleofasciculus chthonoplastes*, *Diatoma vulgare*, *Ellerbeckia arenaria*, *Gomphonema parvulum*, *Lyngbya aestuarii*, *Melosira varians*, *Meridion circulare*, *Microcoleus autumnalis*, *Navicula salinarum*, *N. tripunctata*, *Oscillatoria limosa*, *Planothidium lanceolatum*, *Rhoicosphenia abbreviata*, *Rivularia nitida*, *Spirulina subsalsa*, *Tryblionella hungarica*, *Ulnaria ulna*.

Naviculetalia gregariae* Pankow ex Täuscher ordo nov. hoc loco(Naviculetea gregariae)*

VALIDATED NAME: *Naviculetalia* Pankow 1980 (PANKOW, 1980: 136) [Art. 3g].

SYNONYMS: *Tribonemetalia* Margalef 1960 [Art. 2b], *Amphipleuretalia* Margalef 1960 [Art. 2b], *Euastretalia* Margalef 1960 [Art. 2b], *Naviculetalia* Pankow ex Täuscher 1997 (TÄUSCHER, 1997: 13) [Arts. 2b, 3g], *Naviculetalia* Pankow ex Täuscher 1998 (TÄUSCHER, 1998: 631) [Art. 3g].

TYPE: *Holotypus hoc loco*: *Meridio-Naviculion gregariae* M. Schlüter 1961 (SCHLÜTER, 1961: 585-586, 606 & Table 2 on pp. 573-579).

CHARACTER TAXA OF THE ORDER: the same taxa as for the *Naviculetea gregariae* (see above).

Oscillatorion limosae* Täuscher *all. nov. hoc loco

(*Naviculetalia gregariae*, *Naviculetea gregariae*)

VALIDATED NAME: *Oscillatorion* Möller 1977 (MÖLLER, 1977: 62) [Art. 1].

SYNONYMS: *Oscillatorion* Prát in Klika et Hadač 1944 [phantom], *Limoseto-Diatomeion* Fetzmann 1956 [Arts. 2c, 3b], *Oscillatorion* Möller et Pankow 1981 (MÖLLER & PANKOW, 1981: 321) [Art. 2b], *Oscillatorion* Täuscher 1998 (TÄUSCHER, 1998: 631) [Art. 2b].

TYPE: *Holotypus hoc loco*: *Oscillatorietum limosae* Möller et Pankow ex Täuscher in Bültmann et al. 2015 (see below).

CHARACTER TAXA OF THE ALLIANCE: *Microcoleus autumnalis*, *Oscillatoria limosa*, *O. tenuis*, *Phormidium chalybeum*, *Pseudanabaena limnetica*, *Spirulina subsalsa*.

Oscillatorietum limosae* Möller & Pankow ex Täuscher *ass. nov. hoc loco

(*Oscillatorion limosae*, *Naviculetalia gregariae*, *Naviculetea gregariae*)

VALIDATED NAME: *Oscillatorietum limosae* Möller et Pankow 1981 (MÖLLER & PANKOW, 1981: 318-319) [Art. 5].

SYNONYMS: *Schlamm-Oscillatorietum* Kurz 1922 [Art. 2b], *Oscillatorietum limosae* Prát ex Klika et Hadač 1944 [Art. 2b].

TYPE: *Holotypus hoc loco*: *Möller & Pankow* (1981: 318. Table 8, relevé 7).

CHARACTER TAXA OF THE ASSOCIATION: *Oscillatoria limosa*, *O. tenuis*, *Phormidium chalybeum*, *Pseudanabaena limnetica*.

A NEW ALLIANCE AND ASSOCIATION IN THE *ASTERIONELLETEA FORMOSAE*

The *Asterionelletea formosae* and the *Asterionelletalia formosae* were described in a thesis multiplied by hectograph (TÄUSCHER, 1981), which is not effectively published according to ICPN Art. 1 (WEBER & al., 2000). The syntaxon names have been used in several publications (e.g. Täuscher, 1995), but presumed as valid and never unintentionally validated until Täuscher (1998) described the class and the order by listing only one valid alliance *Asterionellion* Möller et Pankow 1981. MÖLLER & PANKOW (1981) validated the alliance by listing only one valid association (*Fragilario crotonensis-Asterionelletum gracillimae* Messikommer 1927), which they proposed to rename to *Fragilario crotonensis-Asterionelletum formosae* because *Asterionella gracillima* (Hantzsch) Heiberg is a synonym of *A. formosa*. According to MÖLLER & PANKOW (1981) the epithet of the alliance should read 'formosae'.

The class and the order include the three alliances, such as the *Asterionellion formosae* Möller et Pankow 1981 (communities dominated by diatoms), the *Aphanizomeno floris-aquae-Microcystion aeruginosae* Täuscher 1995 (dominated by cyanobacteria), and the *Pediastro duplicis-Scenedesmion quadricaudae* (dominated by green microalgae).

Pediastro duplicis-Scenedesmion quadricaudae* Täuscher *all. nov. hoc loco

(*Asterionelletalia formosae*, *Asterionelletea formosae*)

VALIDATED NAME: *Pediastro-Scenedesmion* Täuscher 1981 (TÄUSCHER, 1981: 93) [Art. 1].

SYNONYMS: *Pediastro-Scenedesmion* Täuscher 1995 (TÄUSCHER, 1995: 5) [Arts. 2b, 3g],

Pediastro-Scenedesmion Täuscher 1998 (TÄUSCHER, 1998: 631) [Arts. 2b, 3g].

TYPE: *Holotypus hoc loco*: *Pediastro duplicis-Scenedesmetum quadricaudae* Täuscher in Bültmann et al. 2015 (see below).

CHARACTER TAXA OF THE ALLIANCE: *Actinastrum hantzschii*, *Closterium limneticum*, *Micractinium pusillum*, *Mucidosphaerium pulchellum*, *Pandorina morum*, *Pediastrum duplex*, *Scenedesmus quadricauda*.

***Pediastro duplicis-Scenedesmetum quadricaudae* Täuscher ass. nov. hoc loco**

(*Pediastro duplicis-Scenedesmion quadricaudae*, *Asterionelletalia formosae*, *Asterionelletea formosae*)

VALIDATED NAME: *Pediastro-Scenedesmetum* Täuscher 1995 (TÄUSCHER, 1995: 8) [Arts. 2b, 3g].

TYPE: *Holotypus hoc loco*: TÄUSCHER (1995: 8. Table 1 consists of one relevé, which is the holotype).

CHARACTER TAXA OF THE ASSOCIATION: *Pediastrum duplex*, *Scenedesmus quadricauda*.

A NEW CLASS AND ORDER FOR THE VEGETATION OF AEROPHYTIC MICROALGAL FILMS ON CALCAREOUS ROCKS

GOLUBIĆ (1967) described nine associations of vegetation of rock algae in the Dinarides in the alliance *Gloeocapsion sanguineae* Golubić 1967. Weak floristic relations link those communities to the syntaxa of benthic aquatic algae, but the strong differences made it impossible to classify the aerophytic rock algae communities to the *Naviculetea*, and thus a new class and new order have to be described.

Gloeocapsa sanguinea is a widely distributed cyanobacterium, which is typical for moist surfaces of calcareous substrates, e.g. in the black patina or tintenstrichen on rocks, cement walls and monuments (e.g. SAMAD & ADHIKARY, 2008; GOLUBIĆ & al., 2015) or in the 'lampenflora' in Karst caves (MULEC & KOSI, 2009). It is also known as a photobiont in lichens (BÜDEL & HENSSEN, 1988).

***Gloeocapsetea sanguineae* Bültmann & Golubić class. nov. hoc loco**

TYPE: *Holotypus hoc loco*: *Gloeocapsetalia sanguineae* Bültmann et Golubić in Bültmann et al. 2015 (see below).

CHARACTER TAXA OF THE CLASS: *Gloeocapsa biformis*, *G. compacta*, *G. kuetzingiana*, *G. sanguinea*, *Schizothrix heufleri*, *Scytonema myochrous*.

***Gloeocapsetalia sanguineae* Bültmann & Golubić ordo nov. hoc loco**

(*Gloeocapsetea sanguineae*)

TYPE: *Holotypus hoc loco*: *Gloeocapsion sanguineae* Golubić 1967 (GOLUBIĆ, 1967: 165-166. Tables 13 & 14).

CHARACTER TAXA OF THE ORDER: the same taxa as for the *Gloeocapsetea sanguineae* (see above).

A NEW CLASS, ORDER AND ALLIANCE FOR THE GREEN ALGAE FILMS ON BARK AND ACIDIC ROCKS

The species composition of biofilms of green algae was studied frequently in context of biodeterioration, however rarely using phytosociological methods. It is therefore, that the alliance *Schizogonion cruenti* Ochsner 1928, containing described three associations (*Pleurococetum vulgaris*, *Schizogonietum crenulatae* and *Trentepohlietum abietinae*; all nomina nuda) remained a *nomen nudum* since it had been suggested by OCHSNER (1928).

One species common in those biofilms is *Desmococcus olivaceus*, which is often listed as one of its synonyms such as *Desmococcus viridis* (C. Agardh) P.C. Silva, *Desmococcus vulgaris* F. Brand, *Pleurococcus viridis* (C. Agardh) Rabenh. or *Pleurococcus vulgaris* Nägeli (LAUNDON, 1985). *Apatococcus lobatus* (Chodat) J.B. Petersen is another common species of the green algal films (e.g. BRAND, 1925; BARKMAN, 1958), and GÄRTNER &

INGOLIĆ (1989); GÄRTNER (1994) proposed to replace the name *Pleurococcetum vulgaris* with the *Apatococcetum lobati* but never supported their proposal with a publication of relevés showing that *Apatococcus lobatus* is more frequent than *Desmococcus olivaceus*. Other authors found *Desmococcus* in equal or higher abundance than *Apatococcus* (RINDI & GUIRY, 2003; RINDI, 2007). It is possible, that *Desmococcus* prefers moister sites and it is more common in the Atlantic Europe, while *Apatococcus* prefers continental areas and drier habitats (GUSTAVS, 2010). The *Desmococcion olivacei* comprises the two validly published associations, such as the *Pleurococcetum vulgaris* Schorler ex Barkman 1958 dominated by water-repellent coccoid green algae and the *Prasiolletum crispae* Knebel ex Barkman 1958, dominated by filamentous algae. (*Schizogonium crenulatum* (Kütz.) Gay is a synonym of *Prasiola crispa* (Lightfoot) Kützing.)

***Desmococcetea olivacei* Bültmann class. nov. hoc loco**

TYPE: *Holotypus hoc loco*: *Desmococcetalia olivacei* Bültmann in Bültmann et al. 2015 (see below).
CHARACTER TAXA OF THE CLASS: *Apatococcus lobatus*, *Desmococcus olivaceus*, *Klebsormidium flacidum*, *Porphyridium purpureum*, *Prasiola crispa*, *Rosenvingiella radicans*, *Schizogonium murale*, *Trentepohlia abietina*, *Trentepohlia umbrina*.

***Desmococcetalia olivacei* Bültmann ordo nov. hoc loco**

(*Desmococcetea olivacei*)

TYPE: *Holotypus hoc loco*: *Desmococcion olivacei* Bültmann in Bültmann et al. 2015 (see below).
CHARACTER TAXA OF THE ORDER: the same taxa as for the *Desmococcetea olivacei* (see above).

***Desmococcion olivacei* Bültmann all. nov. hoc loco**

(*Desmococcetalia olivacei*, *Desmococcetea olivacei*)

TYPE: *Holotypus hoc loco*: *Pleurococcetum vulgaris* Schorler ex Barkman 1958 (BARKMAN, 1958: 341).

SYNONYMS: *Schizogonium cruenti* Ochsner 1928 (OCHSNER, 1928: 47) [Art. 2b], *Schizogonium cruenti* Ochsner in Klika et Hadač 1944 [Art. 2b].

CHARACTER TAXA OF THE ALLIANCE: the same taxa as for the *Desmococcetea olivacei* (see above).

MESOTAENIETEA BERGGRENII - A NEW CLASS AND SUBORDINATE SYNTAXA FOR SNOW ALGAE

KLIKA & HADAČ (1944) proposed the *Sphaerellion nivalis* Hadač in Klika & Hadač 1944 for the snow algae syntaxa, yet this name remained a *nomen nudum*. The vegetation and habitat of the snow algae is so unique, that the vegetation could not be placed in any existing class. Communities of snow and ice algae have been studied in Antarctica (e.g. FOGG, 1967) to Alaska (e.g. TAKEUCHI, 2001). Besides strong floristic difference depending on the growth on permanent snow or ice as the substrate (e.g. KOL, 1942), further variations have been observed with altitude and ecoregion (TAKEUCHI, 2013). The evaluation of samples, which are equivalent to relevés (KOL, 1942; FOGG, 1967; TAKEUCHI, 2001), suggests at least two associations, such as the *Mesotaenietum berggrenii* for ice algae and the *Chloromonadetum nivalis* for snow algae, both are described here based on samples from Alaska.

Chlamydomonas nivalis is the collective name for algae responsible for the red snow and this taxonomic concept was used to describe (invalidly) the *Chlamydomonadetum nivalis* (PANKOW & al., 1991). However since the taxonomy of this 'species' is not clear (e.g. REMIAS & al., 2013) another characteristic species, the ice alga *Mesotaenium berggrenii*, was chosen to give the name to class, order and alliance.

Mesotaenietea berggrenii Bültmann et Takeuchi class. nov. hoc loco

TYPE: *Holotypus hoc loco*: *Mesotaenietalia berggrenii* Bültmann et Takeuchi in Bültmann et al. 2015 (see below).

CHARACTER TAXA OF THE CLASS: *Ancylonema nordenskioldii*, *Chlamydomonas nivalis*, *Chloromonas nivalis*, *Cryocystis brevispina*, *Desmotetra antarctica*, *Mesotaenium berggrenii*, *Raphidonema nivale*.

TYPE: *Holotypus hoc loco*: TAKEUCHI (2001: 3452. Table I, sample 5, Alaska): *Mesotaenium berggrenii* 20371 cells, *Ancylonema nordenskioldii* 6439 cells/ml, *Chlamydomonas nivalis* 487 cells/ml, *Cylindrocystis brebissonii* 243 cells/ml, *Raphidonema* sp. 54 cells/ml, *Oscillatoriaceae* spec. 1 34330 cells/ml, *Osc.* spec. 2 16177 cells/ml.

CHARACTER TAXA OF THE ASSOCIATION: *Ancylonema nordenskioldii*, *Mesotaenium berggrenii*.

Mesotaenietalia berggrenii Bültmann et Takeuchi ordo nov. hoc loco
(*Mesotaenietea berggrenii*)

TYPE: *Holotypus hoc loco*: *Mesotaenion berggrenii* Bültmann et Takeuchi in Bültmann et al. 2015 (see below).

CHARACTER TAXA OF THE ORDER: *Ancylonema nordenskioldii*, *Chlamydomonas nivalis*, *Chloromonas nivalis*, *Mesotaenium berggrenii*, *Raphidonema nivale*.

Mesotaenion berggrenii Bültmann et Takeuchi all. nov. hoc loco
(*Mesotaenietalia berggrenii*, *Mesotaenietea berggrenii*)

TYPE: *Holotypus hoc loco*: *Mesotaenietum berggrenii* Bültmann et Takeuchi in Bültmann et al. 2015 (see below).

SYNONYMS: *Sphaerellion nivalis* Hadač in Klika et Hadač 1944 [2b], *Sphaerellion nivalis* Hadač ex Klika 1948 [Art. 2b], *Sphaerellion nivalis* Hadač 1962 [Art. 2b].

CHARACTER TAXA OF THE ALLIANCE: the same taxa as for the *Mesotaenietalia berggrenii* (see above).

Mesotaenietum berggrenii Bültmann et Takeuchi ass. nov. hoc loco
(*Mesotaenion berggrenii*, *Mesotaenietalia berggrenii*, *Mesotaenietea berggrenii*)**Chloromonadetum nivalis Bültmann et Takeuchi ass. nov. hoc loco**
(*Mesotaenion berggrenii*, *Mesotaenietalia berggrenii*, *Mesotaenietea berggrenii*)

TYPE: *Holotypus hoc loco*: KOL (1942: Sample 35, Alaska, Thompson Pass, red snow, abundance and species data on pages 17, 19, 20, 21, 23, 27): *Smithsonimonas abbotii* very abundant, *Chlamydomonas nivalis* abundant, *Chloromonas nivalis* abundant, *Gloeocapsa sanguinea* (incl. *G. ralfsii* (Harvey) Lemmermann) not rare, *Mycacanthococcus cellaris* f. *antarcticus* rare, *Protoderma cohaerens* rare, *Raphidonema brevirostre* rare, *Raphidonema nivale* rare.

SYNONYMS: *Chlamydomonadetum nivalis* Gams 1927 [Art. 2b], *Chlamydomonadetum nivalis* Gams 1936 [Art. 2b], *Chlamydomonadetum nivalis* Pankow et al. 1991 [Art. 2b].

CHARACTER TAXA OF THE ASSOCIATION: *Chlamydomonas nivalis*, *Chloromonas nivalis*.

VALIDATIONS AND TYPIFICATIONS IN THE ENTOPHYSALIDETEA DEUSTAE

The *Entophysalidetea* comprises the marine photophytic algal vegetation on hard substrates in lower supralittoral and upper parts of eu-littoral level. Unfortunately in the description *expressis verbis*, the association *Lithophylletum lichenoidi*, was chosen as type of the class (GIACCONE & al., 1993) hence rendering the class invalid according to the ICPN. Here we provide an ICPN-conform typification.

This class includes the *Pleurocapsetalia gloeocapsoidis* Ercegovic 1932 in the supralittoral zone of the Atlantic and the Mediterranean (with two alliances), the *Bangietalia atropurpureae* Giaccone in Giaccone et al. 1993 in the upper eu-littoral and the *Neogoniolitho notarisii-Nemodermetalia tingitani* Molinier 1960 in the lower eu-littoral of the Mediterranean (one alliance each), the *Fucetalia vesiculosi* with two new alliances for the upper and lower eu-littoral of the Atlantic and, finally the *Dalmatellietalia polyformis* Ercegovic 1932 and the *Hyelletalia caespitosae* Ercegovic 1932 described from limestone coasts of the Eastern Mediterranean (with two alliances each). Several of the characteristic species of the two orders by ERCEGOVIC (1932) are also known from the Atlantic limestone coasts and it is possible that these poorly-known syntaxa are not exclusively Mediterranean.

Entophysalidetea deustae* Giaccone class. nov. *hoc loco

VALIDATED NAME: *Entophysalidetea deustae* Giaccone in Giaccone et al. 1993 (GIACCONE & al., 1993: 262, 270) [Art. 5].

SYNONYMS: *Chthamaletea* Giaccone 1965 [Art. 2c], *Melarphetea neritoidis* Giaccone 1965 p.p. [Art. 2c], *Dictyoto dichotomae-Laurencietea pinnatifidae* Julve 1992 p.p. [Art. 5], *Peyssonnelio dubyi-Lithophylletea incrustantis* Julve 1992 p.p. [Art. 2b], *Fucetea* Golub et al. 2003 [Arts. 2b, 5], *Dictyoto dichotomae-Osmundeetea pinnatifidae* Julve ex Julve et Manneville 2006 p.p. [Art. 3i].

TYPE: *Holotypus hoc loco*: *Ralfsietalia verrucosae* Giaccone 1993 (GIACCONE & al., 1993: 269, 281).

CHARACTER TAXON OF THE CLASS: *Brachytrichia quoyi*.

***Fucetalia vesiculosi* Julve ordo nov. *hoc loco* (*Entophysalidetea deustae*)**

VALIDATED NAME: *Fucetalia vesiculosi* Julve 1992 (JULVE, 1992: 566-567) [Art. 2b].

SYNONYMS: *Fucetalia* Hadač in Klika 1948 [Art. 2b], *Fucetalia* Golub et al. 2003 [Arts. 2b, 5], *Ascophyllo nodosi-Fucetalia serrati* Julve et Manneville 2006 [Art. 3i].

TYPE: *Holotypus hoc loco*: *Ascophyllion nodosi* Julve in Bültmann et al. 2015 (see below).

CHARACTER TAXA OF THE ORDER: *Cladophora rupestris* and the character taxa of the alliances, e.g. *Ascophyllum nodosum*, *Fucus serratus*, *F. vesiculosus*, *Pelvetia canaliculata*.

***Ascophyllion nodosi* Julve all. nov. *hoc loco* (*Fucetalia vesiculosi*, *Entophysalidetea deustae*)**

VALIDATED NAME: *Ascophyllion nodosi* Julve et Manneville 2006 (JULVE & MANNEVILLE, 2006: 222-223. Table 1) [Art. 5].

SYNONYMS: *Dictyosiphonion foeniculacei* Du Rietz 1941 [Art. 2b], *Dictyosiphonion* Du Rietz ex Klika 1948 [Art. 2b], *Pelvetion canaliculatae* Hadač in Klika 1948 [Art. 2b], *Fucion* Golub et al. 2003 [Arts. 2b, 5].

TYPE: *Holotypus hoc loco*: *Ascophylletum nodosi* den Hartog 1959 (DEN HARTOG, 1959: 199-204).

CHARACTER TAXA OF THE ALLIANCE: *Ascophyllum nodosum*, *Bostrychia scorpioides*, *Catenella caespitosa*, *Fucus ceranoides*, *F. spiralis*, *F. vesiculosus*, *Pelvetia canaliculata*, *Vertebrata lanosa*.

VALIDATIONS IN THE *CYSTOSEIRETEA*

The *Cystoseiretea* Giaccone 1965 comprises the Mediterranean *Cystoseiretalia* Molinier 1960, the Atlantic *Laminarietalia hyperboreae* Julve 1992, and the thio-nitrophytic *Ulvetalia lactucae* Molinier 1960 occurring in in both Atlantic Ocean and the Mediterranean Sea.

The *Laminarietalia* include the *Laminarion saccharinae* Julve 1992 in protected coastal habitats and the *Laminarion hyperboreae* in more dynamic habitats. JULVE & MANNEVILLE (2006) used the name *Cystoseirion tamariscifoliae*, but as no such species occurs in the relevés of the original diagnosis, the name *Laminarion hyperboreae*,

was chosen instead. JULVE & MANNEVILLE (2006) described the *Alario esculenti-Himanthalietum elongatae* and the *Saccorhizo polyschidi-Laminarietum hyperborea* by presenting only a synoptic table. The alliance and both associations are validated here:

***Laminarion hyperborea* Julve all. nov. hoc loco**

(*Laminarietalia hyperborea*, *Cystoseiretea*)

VALIDATED NAME: *Cystoseirion tamariscifoliae* Julve 1992 (JULVE, 1992: 568) [Art. 2b]

SYNONYM: *Cystoseirion baccatae* Julve 1992 [Art. 2b].

TYPE: *Holotypus hoc loco*: *Saccorhizo polyschidi-Laminarietum hyperborea* Julve in Bültmann et al. 2015 (see below).

CHARACTER TAXA OF THE ALLIANCE: *Alaria esculenta*, *Calliblepharis jubata*, *Chylocladia verticillata*, *Dilsea carnososa*, *Halopteris scoparia*, *Himanthalia elongata*, *Laminaria digitata*, *L. hyperborea*, *Lomentaria clavellosa*, *Saccorhiza polyschides*.

***Saccorhizo polyschidi-Laminarietum hyperborea* Julve ass. nov. hoc loco**

(*Laminarion hyperborea*, *Laminarietalia hyperborea*, *Cystoseiretea*)

VALIDATED NAME: *Saccorhizo polyschidi-Laminarietum hyperborea* Julve et Manneville 2006 (JULVE & MANNEVILLE, 2006: 225. Table 1) [Art. 2b].

TYPE: *Holotypus hoc loco*: JULVE & MANNEVILLE (2006) included a column of a synoptic table, but the full table was presented online. Here the relevé 235 had been extracted from that source is presented as the holotype:

France, Bretagne, upper infralittoral, growing on rock face, exposed to wave action (cover scale: + to 5): *Laminaria hyperborea* 4, *Chondrus crispus* 2, *Ellisolandia elongata* 2, *Laminaria digitata* 2, *Palmaria palmata* 2, *Saccorhiza polyschides* 2, *Callophyllis laciniata* 1, *Corallina officinalis* 1, *Cryptopleura ramosa*

1, *Dilsea carnososa* 1, *Furcellaria lumbricalis* 1, *Halurus flosculosus* 1, *Membranoptera alata* 1, *Osmundea pinnatifida* 1, *Calliblepharis jubata* +, *Callithamnion tetragonum* +, *Ceramium virgatum* +, *Chondracanthus acicularis* +, *Clavicolonium ovatum* +, *Codium tomentosum* +, *Desmarestia aculeata* +, *Gelidium pulchellum* +, *Halurus equisetifolius* +, *Heterosiphonia plumosa* +, *Plocamium cartilagineum* +.

CHARACTER TAXA OF THE ASSOCIATION: *Calliblepharis jubata*, *Dilsea carnososa*, *Laminaria hyperborea*, *Saccorhiza polyschides*.

***Alario esculenti-Himanthalietum elongatae* Julve ass. nov. hoc loco.**

(*Laminarion hyperborea*, *Laminarietalia hyperborea*, *Cystoseiretea*)

VALIDATED NAME: *Alario esculenti-Himanthalietum elongatae* Julve & Manneville 2006 (JULVE & MANNEVILLE, 2006: 225. Table 1) [Art. 2b].

TYPE: *Holotypus hoc loco*: JULVE & MANNEVILLE (2006) include a column of a synoptic table, but the full table is given online only. Here the relevé 78 is selected from from that source as the holotype: France, Bretagne, eu- to infralittoral, growing on rock exposed to strong wave action (cover scale: + to 5): *Himanthalia elongata* 4, *Corallina elongata* 3, *Mastocarpus stellatus* 3, *Osmundea pinnatifida* 2, *Alaria esculenta* 1, *Bifurcaria bifurcata* 1, *Boergeseniella thuyoides* 1, *Chondrus crispus* 1, *Chylocladia verticillata* 1, *Laminaria digitata* 1, *Cladophora rupestris* +, *Codium tomentosum* +, *Lomentaria articulata* +, *Lomentaria clavellosa* +, *Polysiphonia stricta* +.

CHARACTER TAXA OF THE ASSOCIATION: *Alaria esculenta*, *Chylocladia verticillata*, *Halopteris scoparia*, *Himanthalia elongata*, *Lomentaria clavellosa*.

A NEW ORDER AND ALLIANCE IN THE LITHOPHYLLETEA SOLUTI

The class *Lithophylletea soluti* Giaccone 1965 includes two Mediterranean orders

(*Rhodymenietalia ardissoni* Augier et Boudouresque 1975 and *Lithophylletalia soluti* Giaccone 1965) and the Atlantic *Delesserietalia sanguinei*. The validation of the latter is necessary because in JULVE (1992), the class, the order and the associations were listed without the name of an alliance and JULVE & MANNEVILLE (2006) described the alliance with one invalid association only.

Delesserietalia sanguinei* Julve *ordo nov. hoc loco
(*Lithophylletea soluti*)

VALIDATED NAME: *Delessertietalia sanguinei* Julve 1992 (JULVE, 1992: 569-570) [Art. 2b].

TYPE: *Holotypus hoc loco*: *Delesserion sanguineae* Julve in Bültmann et al. 2015 (see below).

CHARACTER TAXA OF THE ORDER: *Agarum clathratum*, *Alaria esculenta*, *Bonnemaisonia hamifera*, *Calliblepharis ciliata*, *Callithamnion tetricum*, *Chondrus crispus*, *Coccotylus truncatus*, *Delesseria sanguinea*, *Fimbrifolium dichotomum*, *Gigartina pistillata*, *Heterosiphonia plumosa*, *Membranoptera alata*, *Odonthalia dentata*, *Phycodrys rubens*, *Phyllophora pseudocera-noïdes*, *Plumaria plumosa*, *Polysiphonia arctica*, *Ptilota gunneri*, *Stenogramma interruptum*.

Delesserion sanguinei* Julve *all. nov. hoc loco
(*Delesserietalia sanguinei*, *Lithophylletea soluti*)

VALIDATED NAME: *Delesserion sanguineae* Julve et Manneville 2006 (JULVE & MANNEVILLE, 2006: 225-226. Table 1) [Art. 2b].

SYNONYM: *Polysiphonion arcticae* Hadač in Klika 1948 [Art. 2b].

TYPE: *Holotypus hoc loco*: *Delesserietum sanguineae* Julve in Bültmann et al. 2015 (see below).

CHARACTER TAXA OF THE ALLIANCE: the same as for the order (see above).

Delesserietum sanguineae* Julve *ass. nov. hoc loco

(*Delesserion sanguinei*, *Delesserietalia sanguinei*, *Lithophylletea soluti*)

VALIDATED NAME: *Heterosiphonio plumosi-Delesserietum sanguineae* Julve et Manneville 2006 (JULVE & MANNEVILLE, 2006: 226. Table 1) [Art. 2b].

TYPE: *Holotypus hoc loco*: JULVE & MANNEVILLE (2006) included a column of a synoptic table; full relevé table was presented online and here we select the relevé 133 from this source and present as the holotype:

France, Bretagne, eu-littoral, on rock in a shaded pool, exposed to wave action (cover scale: + to 5): *Phyllophora crispa* 4, *Plumaria plumosa* 3, *Corallina officinalis* 2, *Ceramium virgatum* 1, *Laminaria digitata* 1, *Delesseria sanguinea* +.

CHARACTER TAXA OF THE ASSOCIATION: *Apoglossum ruscifolium*, *Delesseria sanguinea*, *Halurus equisetifolius*, *Heterosiphonia plumosa*, *Phyllophora crispa*, *Pleonosporium borneri*, *Plumaria plumose*.

VALIDATION IN THE *CAULERPETEA RACEMOSAE*

The *Caulerpetea racemosae* includes one order and one alliance with five associations dominated by species of *Caulerpa* (*Caulerpetum racemosae* Giaccone et Di Martino 1995, *Caulerpetum scalpelliformis* Mayhoub ex Giaccone & Di Martino 1995, *Caulerpetum mexicanae* Giaccone et Di Martino 1995, *Caulerpetum taxifoliae* Di Martino et Giaccone 1997 and *Caulerpetum proliferae* Giaccone et Di Martino 1997). In the original description of the higher syntaxa, the genus name was used without epithet and hence is not possible to decide, which of several *Caulerpa* were the name-giving species.

Caulerpetea racemosae* Giaccone et Di Martino *class. nov. hoc loco

VALIDATED NAME: *Caulerpeteae* Giaccone et Di Martino 1997 (GIACCONE & DI MARTINO, 1997: 6) [Art. 3g].

TYPE: *Holotypus hoc loco: Caulerpetalia racemosae* Giaccone et Di Martino in Bültmann et al. 2015 (see below).

CHARACTER TAXA OF THE CLASS: *Caulerpa prolifera*, *C. racemosa*.

***Caulerpetalia racemosae* Giaccone et Di Martino ordo nov. hoc loco**
(*Caulerpetea racemosae*)

VALIDATED NAME: *Caulerpetalia* Giaccone et Di Martino 1997 (GIACCONE & DI MARTINO, 1997: 6) [Art. 3g].

TYPE: *Holotypus hoc loco: Caulerpion racemosae* Giaccone et Di Martino in Bültmann et al. 2015 (see below).

CHARACTER TAXA OF THE ORDER: the same as for the *Caulerpetea racemosae* (see above).

***Caulerpion racemosae* Giaccone et Di Martino all. nov. hoc loco**
(*Caulerpetalia racemosae*, *Caulerpetea racemosae*)

VALIDATED NAME: *Caulerpion* Giaccone et Di Martino 1997 (GIACCONE & DI MARTINO, 1997: 6) [Art. 3g].

TYPE: *Holotypus hoc loco: Caulerpetum racemosae* Giaccone et Di Martino 1995 (GIACCONE & DI MARTINO, 1995: 66, 68-70).

CHARACTER TAXA OF THE ALLIANCE: the same as for the *Caulerpetea racemosae* (see above).

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Table 1

Classes of the thallophyte syntaxa, contributors (B: bryophytes, L: lichens, A: algae & cyanobacteria) and their habitat type (*Cladonio-Lepidozietea* and *Desmococcetea olivacei* are listed twice).

Syntaxa	Contributors	Habitat type
On Soil		
<i>Funarietea hygrometricae</i>	B	habitats with easily accessible nutrients (charcoal, bones, fur, animal droppings)
<i>Ceratodonto purpurei-</i> <i>Polytrichetea piliferi</i>	B&L	dry acid and nutrient poor soil
<i>Psoretea decipiens</i>	B&L	subneutral and calcareous soil
<i>Hylocomietea splendentis</i>	B	large, competitive bryophytes on dry soil or thin soil layers on boulders
<i>Cladonio digitatae-</i> <i>Lepidozietea reptantis</i>	B&L	moist acidic loamy soils and deadwood or other decaying organic matter
<i>Campylopodetea vaporarii</i>	B	Mediterranean fumaroles
<i>Bracteacocco minoris-</i> <i>Hantzschietea amphioxys</i>	A	soil algae vegetation described from the steppe zone of southern Urals
Non-aquatic rock and hard substrate		
<i>Racomitrietea heterostichi</i>	B	exposed siliceous rocks
<i>Rhizocarpetea geographici</i>	L	exposed siliceous rocks
<i>Schistidietea apocarpi</i>	B	exposed limestone rock
<i>Ctenidietea mollusci</i>	B	shaded and rather moist limestone or occasionally calcareous soil
<i>Clauzadeetea immersae</i>	L	nutrient-poor limestone
<i>Verrucarietea nigrescentis</i>	L	nutrient-rich limestone
<i>Aspicilietea candidae</i>	L	subalpine and alpine calcareous schists and decalcified limestone with short-time snow cover
<i>Porpidietea zeoroidis</i>	L	subalpine and alpine calcareous schists and decalcified limestone with long-time snow cover
<i>Collematetea cristati</i>	L	jelly lichens on calcareous or base-rich rocks in places temporarily inundated by seepage or trickling water
<i>Leprarietea chlorinae</i>	L	acidic rock in sites protected from rain
<i>Roccelletea phycopsis</i>	L	calcareous and subacidic rock in sites protected from rain
<i>Gloeocapsetea sanguineae</i>	A	aerophytic microalgae on calcareous rock
<i>Desmococcetea olivacei</i>	A	aerophytic microalgae on acidic bark or rock
Epiphytic		
<i>Neckeretea complanatae</i>	B&L	large bryophytes and lichens on shaded and thinly soil-covered basic rocks and on bark
<i>Frullanio dilatatae-</i> <i>Leucodonteteasciuroidis</i>	B	bark and on leaves
<i>Arthonio radiatae-</i> <i>Lecidelletea elaeochromae</i>	L	crustose lichens on smooth, neutral to subacidic bark
<i>Hypogymnietea physodis</i>	L	acidic nutrient-poor bark
<i>Fellhaneretea bouteillei</i>	L	epiphyllous lichens
<i>Physcietea</i>	L	highly nutrient-rich bark
<i>Leprarietea candellaris</i>	L	bark in situations protected from rain
<i>Cladonio digitatae-</i> <i>Lepidozietea reptantis</i>	B&L	moist acidic loamy soils and deadwood or other decaying organic matter
<i>Desmococcetea olivacei</i>	A	aerophytic microalgae on acidic bark or rock
In freshwater, brackish water and on ice		
<i>Platyhypnidio-Fontinalietea</i> <i>antipyreticae</i>	B(&L)	hard substrate submerged in freshwater
<i>Aspicilietea lacustris</i>	L	hard substrate in very clear freshwater
<i>Lemaneetea fluviatilis</i>	A	hard substrate in current or turbulent freshwater
<i>Stigeoclonietea tenuis</i>	A	benthic macroalgae in eutrophic water with green filamentous and yellow-green siphon algae
<i>Charetea</i>	A	submerged stonewort swards in brackish and freshwater water on soft substrate
<i>Naviculetea gregariae</i>	A	benthic microalgae of brackish and freshwater
<i>Asterionelletea formosae</i>	A	planctonic microalgae of brackish and freshwater
<i>Mesotaenietea berggrenii</i>	A	permanent snow and ice

In marine habitats

<i>Verrucarietea maura</i>	L	rocks from supralittoral to the eu-littoral levels just above the algal levels
<i>Entophysalidetea deustae</i>	A	rocks of the supra- and eulittoral levels
<i>Cystoseiretea</i>	A	well-insolated habitats of infralittoral and circalittoral levels
<i>Lithophylletea soluti</i>	A	shaded habitats of infralittoral and circalittoral levels
<i>Caulerpetea racemosae</i>	A	soft substrates at the lower tidal levels of the Mediterranean Sea

Appendix 1: List of taxa (with authorities) used in this paper.**Lichens**

<i>Acarospora freyi</i> H. Magn.	<i>Lecanora dispersoareolata</i> (Schaer.) Lamy
<i>Acarospora hospitans</i> H. Magn.	<i>Lecidea conflouescens</i> Nyl.
<i>Acarospora impressula</i> Th. Fr.	<i>Lecidea leprosolimbata</i> (Arnold) Lettau ex Poelt
<i>Acarospora scabra</i> (Pers.) Th. Fr.	<i>Lecidea speirodes</i> Nyl.
<i>Adelolecia kolaensis</i> (Nyl.) Hertel et Rambold	<i>Lecidea tessellata</i> Flörke var. <i>caesia</i> (Anzi) Arnold
<i>Alyxoria mougeotii</i> (A. Massal.) Ertz, Frisch et G. Thor	<i>Lecidea umbonata</i> (Hepp) Mudd
<i>Alyxoria variiformis</i> (Anzi) Ertz	<i>Lichinella cribellifera</i> (Nyl.) P. P. Moreno et Egea
<i>Alyxoria subelevata</i> (Nyl.) Ertz et Tehler	<i>Lichinella iodopulchra</i> (Couderc ex Croz.) P. P. Moreno et Egea
<i>Anema decipiens</i> (A. Massal.) Forssell	<i>Metamelanea caesiella</i> (Th. Fr.) Hennssen
<i>Anema nummularium</i> (Dufour ex Durieu et Mont.) Nyl. ex Forssell	<i>Myriospora scabrida</i> (Hedl. ex H. Magn.) K. Knudsen et L. Arcadia
<i>Aspicilia candida</i> (Anzi) Hue	<i>Opegrapha cesareensis</i> Nyl.
<i>Aspicilia mashiginensis</i> (Zahlbr.) Oxner	<i>Opegrapha lutulenta</i> Nyl.
<i>Aspicilia permutata</i> (Zahlbr.) Clauzade et Rondon	<i>Paralecanographa grumulosa</i> (Dufour) Ertz et Tehler
<i>Aspicilia polychroma</i> Anzi subsp. <i>polychroma</i> chemotype <i>verruculosa</i>	<i>Peccania coralloides</i> (A. Massal.) A. Massal.
<i>Bacidia fraxinea</i> Lönnr.	<i>Peltula euploca</i> (Ach.) Poelt
<i>Bacidia rubella</i> (Hoffm.) A. Massal.	<i>Peltula omphaliza</i> (Nyl.) Wetmore
<i>Bacidina phacodes</i> (Körb.) Vězda	<i>Peltula placodizans</i> (Zahlbr.) Wetmore
<i>Bactrospora patellarioides</i> (Nyl.) Almq.	<i>Phaeophyscia orbicularis</i> (Neck.) Moberg
<i>Bellemerea subcandida</i> (Arnold) Hafellner et Cl. Roux	<i>Physcia caesia</i> (Hoffm.) Fűrnr.
<i>Biatoridium monasteriense</i> J. Lahm ex Körb.	<i>Placynthium nigrum</i> (Huds.) Gray
<i>Caloplaca anchon-phoeniceon</i> Poelt et Clauzade	<i>Placynthium subradiatum</i> (Nyl.) Arnold
<i>Caloplaca insularis</i> Poelt	<i>Placynthium tantaleum</i> (Hepp) Hue
<i>Caloplaca vitellinula</i> (Nyl.) H. Olivier	<i>Polyblastia ardesiaca</i> (Bagl. et Carestia) Zschacke
<i>Candelariella aurella</i> (Hoffm.) Zahlbr.	<i>Polyblastia cupularis</i> A. Massal. var. <i>cupularis</i>
<i>Candelariella vitellina</i> (Hoffm.) Müll. Arg.	<i>Polysporina pusilla</i> (Anzi) M. Steiner ex Kantvilas
<i>Carbonea atronivea</i> (Arnold) Hertel	<i>Porpidia zeoroides</i> (Anzi) Knoph et Hertel
<i>Coenogonium luteum</i> (Dicks.) Kalb et Lücking	<i>Psorotichia diffracta</i> (Nyl.) Forssell
<i>Collema rysssoleum</i> (Tuck.) A. Schneid.	<i>Psorotichia frustulosa</i> Anzi
<i>Dendrographa decolorans</i> (Turner et Borrer ex Sm.) Ertz et Tehler	<i>Psorotichia schaeferi</i> (A. Massal) Arnold
<i>Diplotomma dispersum</i> (Kremp.) Arnold	<i>Pterygiopsis affinis</i> (A. Massal.) Henssen
<i>Dirina massiliensis</i> Durieu et Mont. morphotype <i>massiliensis</i>	<i>Rhizocarpon petraeum</i> (Wulfen) A. Massal.
<i>Dirina massiliensis</i> Durieu et Mont. morphotype <i>sorediata</i>	<i>Rhizoplaca melanophthalma</i> (DC.) Leuckert et Poelt
<i>Farnoldia micropsis</i> (A. Massal.) Hertel	<i>Rinodina confragosa</i> (Ach.) Körb.
<i>Gyalecta derivata</i> (Nyl.) H. Olivier	<i>Roccella fuciformis</i> (L.) DC.
<i>Gyalecta flotowii</i> Körb.	<i>Roccella phycopsis</i> (Ach.) Ach.
<i>Gyalecta liguriensis</i> (Vězda) Vězda	<i>Roccella tinctoria</i> DC.
<i>Lecania erysibe</i> (Ach.) Mudd	<i>Roccella tuberculata</i> Vain.
<i>Lecanographa dialeuca</i> (Cromb.) Egea et Torrente	<i>Roccellographa circumscripta</i> (Taylor) Ertz et Tehler
<i>Lecanora diaboli</i> Frey et Poelt	<i>Rusavskia elegans</i> (Link) S. Y. Kondr. & Kärnefelt
<i>Lecanora dispersa</i> (Pers.) Sommerf.	<i>Teloschistes contortuplicatus</i> (Ach.) Clauzade et Rondon
	<i>Staurothele sapaudica</i> Asta, Clauzade et Cl. Roux
	<i>Staurothele solvens</i> (Anzi) Zschacke
	<i>Thelidium ungeri</i> (Flot.) Körb.
	<i>Thelopsis isiaca</i> Stizenb.

Thelopsis rubella Nyl.
Thyrea girardii (Durieu et Mont.) Bagl. et Carestia
Verrucaria fischeri Müll. Arg.

Non-lichenised fungi:

Aleurodiscus disciformis (DC.) Pat.
Dendrominia dryina (Pers.) Ghobad-Nejhad & Duhem
Didymosphaeria rubicola Berl.
Navicella pileata (Tode) Fabre
Septobasidium quercinum (De Not. & Bagl.) Sacc.

Algae & cyanobacteria:

Achnanthes brevipes C. Agardh
Actinastrum hantzschii Lagerh.
Agarum clathratum Dumort.
Alaria esculenta (L.) Grev.
Amphora coffaeiformis (C. Agardh) Kütz.
Amphora ovalis (Kütz.) Kütz.
Ancylonema nordenskioeldii Berggr.
Anomoeoneis sphaerophora Pfitzer
Apatococcus lobatus (Chodat) J.B. Petersen
Aphanothece stagnina (Spreng.) A. Braun
Apoglossum ruscifolium (Turner) J. Agardh
Ascophyllum nodosum (L.) Le Jolis
Asterionella formosa Hassall
Bifurcaria bifurcata R. Ross
Boergesenella thuyoides (Harv.) Kylin
Bonnemaisonia hamifera Har.
Bostrychia scorpioides (Huds.) Mont.
Brachytrichia quoyi Bornet & Flahault
Brebissonia boeckii (Ehrenb.) E. O'Meara
Calliblepharis ciliata (Huds.) Kütz.
Calliblepharis jubata (Gooden. & Woodw.) Kütz.
Callithamnion tetragonum (With.) Gray
Callithamnion tetricum (Dillwyn) Gray
Callophyllis laciniata (Huds.) Kütz.
Caloneis amphisbaena (Bory) Cleve
Calothrix scopulorum C. Agardh ex Bornet & Flahault
Catenella caespitosa (With.) L.M. Irvine
Caulerpa prolifera (Forssk.) J.V. Lamour.
Caulerpa racemosa (Forssk.) J. Agardh
Ceramium virgatum Roth
Chlamydomonas nivalis (F.A. Bauer) Wille
Chloromonas nivalis (Chodat) Hoham & Mullet
Chondracanthus acicularis (Roth) Fredericq
Chondrus crispus Stackh.
Chylocladia verticillata (Lightf.) Bliding
Cladophora rupestris (L.) Kütz.
Clavicolonium ovatum (J.V. Lamour.) Kraft & Min-Thein
Closterium limneticum Lemmerm.
Cocconeis placentula Ehrenb.
Coccotylus truncatus (Pall.) M.J. Wynne & J.N. Heine
Codium tomentosum Stackh.

Coleofasciculus chthonoplastes (Thur. ex Gomont) M. Siegesmund, J.R. Johans. & Friedl
Corallina elongata J. Ellis & Sol.
Corallina officinalis L.
Cryocystis brevispina (F.E. Fritsch) E. Kol ex Komárek & Fott
Cryptopleura ramosa (Huds.) L. Newton
Delesseria sanguinea (Huds.) J.V. Lamour.
Desmarestia aculeata (L.) J.V. Lamour.
Desmococcus olivaceus (Pers. ex Ach.) J.R. Laundon
Desmotetra antarctica (Fritsch) H.U. Ling
Diatoma vulgare Bory
Dilsea carnosa (Schmidel) Kuntze
Ellerbeckia arenaria (Moore ex Ralfs) R.M. Crawford
Ellisolandia elongata (J.Ellis & Sol.) K.R. Hind & G.W. Saunders
Fimbriolium dichotomum (Lepech.) G.I. Hansen
Fucus ceranoides L.
Fucus serratus L.
Fucus spiralis L.
Fucus vesiculosus L.
Furcellaria lumbricalis (Huds.) J.V. Lamour.
Gelidium pulchellum (Turner) Kütz.
Gigartina pistillata (S.G.Gmel.) Stackh.
Gloeocapsa biformis Erecg.
Gloeocapsa compacta Kütz.
Gloeocapsa kuetzingiana Nägeli ex Kütz.
Gloeocapsa sanguinea (C. Agardh) Kütz.
Gomphonema parvulum (Kütz.) Kütz.
Halopteris scoparia (L.) Sauv.
Halurus equisetifolius (Lightf.) Kütz.
Halurus flosculosus (J. Ellis) Maggs & Hommers.
Heterosiphonia plumosa (J. Ellis) Batters
Himantalia elongata (L.) S.F. Gray
Klebsormidium flaccidum (Kütz.) P.C. Silva, K.R. Mattox & W.H. Blackw.
Laminaria digitata (Huds.) J.V. Lamour.
Laminaria hyperborea (Gunnerus) Foslie
Lomentaria articulata (Huds.) Lyngb.
Lomentaria clavellata (Lightf. ex Turner) Gaillon
Lyngbya aestuarii Liebman ex Gomont
Mastocarpus stellatus (Stackh.) Guiry
Melosira varians C. Agardh
Membranoptera alata (Huds.) Stackh.
Meridion circulare (Grev.) C. Agardh
Mesotaenium berggrenii (Wittr.) Lagerh.
Micractinium pusillum Fresen.
Microcoleus autumnalis (Gomont) Strunecky, Komárek & J.R. Johans.
Mucidosphaerium pulchellum (H.C. Wood) C. Bock, Pröschold & Krienitz
Mycacanthococcus cellaris Hansgirg f. *antarcticus* Wille
Navicula salinarum Grunow
Navicula tripunctata (O.F. Müller) Bory
Odonthalia dentata (L.) Lyngb.
Oscillatoria limosa C. Agardh ex Gomont

- Oscillatoria tenuis* C.Agardh ex Gomont
Osmundea pinnatifida (Huds.) Stackh.
Palmaria palmata (L.) F. Weber & D. Mohr
Pandorina morum (O.F. Müller) Bory
Pediastrum duplex Meyen
Pelvetia canaliculata (L.) Decne. & Thur.
Phormidium chalybeum (Mert. ex Gomont) Anagn. & Komárek
Phycodrys rubens (L.) Batters
Phyllophora crispa (Huds.) P.S. Dixon
Phyllophora pseudoceranoïdes (S.G. Gmel.) Newroth & A.R.A. Taylor
Planothidium lanceolatum (Brébisson ex Kützing) Lange-Bert.
Pleonosporium borneri (Smith) Nägeli
Plocamium cartilagineum (L.) P.S. Dixon
Plumaria plumosa (Huds.) Kuntze
Polysiphonia arctica J. Agardh
Polysiphonia stricta (Dillwyn) Grev.
Porphyridium purpureum (Bory) K.M. Drew & R. Ross
Prasiola crispa (Lightfoot) Kütz.
- Protoderma cohaerens* (Wittrock) Printz
Pseudanabaena limnetica (Lemmerm.) Komárek
Ptilota gunneri P.C. Silva, Maggs & L.M. Irvine
Raphidonema brevirostre Scherffel
Raphidonema nivale Lagerh.
Rhoicosphenia abbreviata (C. Agardh) Lange-Bert.
Rivularia nitida C. Agardh ex Bornet & Flahault
Rosenvingiella radicans (Kütz.) Rindi, L.McIvor & Guiry
Saccorhiza polyschides (Lightf.) Batters
Scenedesmus quadricauda (Turpin) Bréb.
Schizogonium murale Kütz.
Schizothrix heufleri Grunow ex Gomont
Scytonema myochrous C.Agardh ex Bornet & Flahault
Smithsonimonas abbotii Kol
Spirulina subsalsa Oerst. ex Gomont
Stenogramma interruptum (C. Agardh) Mont.
Trentepohlia abietina (Flotow ex Kütz.) Hansg.
Trentepohlia umbrina (Kütz.) Bornet
Tryblionella hungarica (Grunow) Freng.
Ulnaria ulna (Nitzsch) P. Compère
Vertebrata lanosa (L.) T.A. Chr.

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